

## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

To:

HELLBOM, L.  
Albihns Stockholm AB  
Linnégatan 2  
P.O. Box 5581  
S-114 85 Stockholm  
SUÈDE

|  |   |
|--|---|
| Date of mailing (day/month/year)<br>30 January 2001 (30.01.01) | <b>IMPORTANT NOTIFICATION</b>   |
| Applicant's or agent's file reference<br>55924-60630           |   |
| International application No.<br>PCT/SE00/01394                | International filing date (day/month/year)<br>30 June 2000 (30.06.00) |

## 1. The following indications appeared on record concerning:

☐ the applicant      ☐ the inventor      ☒ the agent      ☐ the common representative

## Name and Address

HELLBOM, L.  
Albihns Patentbyrå Stockholm AB  
P.O. Box 5581  
S-114 85 Stockholm  
Sweden

## State of Nationality

## State of Residence

## Telephone No.

+46 8 59 88 72 00

## Facsimile No.

+46 8 59 88 73 00

## Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person      ☒ the name      ☒ the address      ☐ the nationality      ☐ the residence

## Name and Address

HELLBOM, L.  
Albihns Stockholm AB  
Linnégatan 2  
P.O. Box 5581  
S-114 85 Stockholm  
Sweden

## State of Nationality

## State of Residence

## Telephone No.

+46 8 59 88 72 00

## Facsimile No.

+46 8 59 88 73 00

## Teleprinter No.

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

|  |  |
|--|--|
| <input checked="" type="checkbox"/> the receiving Office                   | <input checked="" type="checkbox"/> the designated Offices concerned |
| <input type="checkbox"/> the International Searching Authority             | <input type="checkbox"/> the elected Offices concerned               |
| <input type="checkbox"/> the International Preliminary Examining Authority | <input type="checkbox"/> other:                                      |

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Authorized officer

F. Baechler

Facsimile No.: (41-22) 740.14.35

Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room  
CP2/5C24  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE  
in its capacity as elected Office

Date of mailing (day/month/year)

23 February 2001 (23.02.01)

International application No.

PCT/SE00/01394

Applicant's or agent's file reference

55924-60630

International filing date (day/month/year)

30 June 2000 (30.06.00)

Priority date (day/month/year)

30 June 1999 (30.06.99)

Applicant

HÅKANSSON, Nils, Olof et al

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

18 January 2001 (18.01.01)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

F. Baechler

Telephone No.: (41-22) 338.83.38

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/01394

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F01M 13/04, B01D 45/14, B04B 5/08

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F01M, B01D, B04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                   | Relevant to claim No. |
|-----------|--|-----------------------|
| X         | EP 0286160 A1 (BB ROMICO B.V.), 12 October 1988<br>(12.10.88), column 6, line 25 - column 7, line 33,<br>figures 1-5 | 1-7                   |
| Y         | --   | 8,9                   |
| X         | WO 9423823 A1 (ROMICO HOLD A.V.V.),<br>27 October 1994 (27.10.94), figures 3,4                                       | 1-7                   |
| Y         | --   | 8,9                   |
| X         | WO 9744117 A1 (ROMICO HOLD A.V.V.),<br>27 November 1997 (27.11.97), figure 1   | 1-7                   |
| Y         | --   | 8,9                   |

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>* Special categories of cited documents</li> <li>"A" document defining the general state of the art which is not considered to be of particular relevance</li> <li>"E" earlier document but published on or after the international filing date</li> <li>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</li> <li>"O" document referring to an oral disclosure, use, exhibition or other means</li> <li>"P" document published prior to the international filing date but later than the priority date claimed</li> </ul> | <ul style="list-style-type: none"> <li>"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</li> <li>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</li> <li>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</li> <li>"&amp;" document member of the same patent family</li> </ul> |
|--|--|

Date of the actual completion of the international search

8 Sept 2000

Date of mailing of the international search report

16 -10- 2000

Name and mailing address of the ISA:

Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. +46 8 666 02 86

Authorized officer

Jan-Axel Ylivainio/js  
Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/01394

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |   |                       |
|---|---|-----------------------|
| Category*   | Citation of document, with indication, where appropriate, of the relevant passages    | Relevant to claim No. |
| Y   | US 5542402 A (LEE ET AL), 6 August 1996 (06.08.96),<br>figures 1-8, abstract<br>----- | 8,9                   |

INTERNATIONAL SEARCH REPORT  
Information on patent family members

International application No.  
PCT/SE 00/01394

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)  | Publication<br>date  |
|---|---------------------|---|--|
| EP 0286160 A1                             | 12/10/88            | SE 0286160 T3<br>AT 52936 T<br>DE 3860159 D<br>GR 3000514 T<br>JP 1135516 A<br>JP 2710624 B<br>NL 8700698 A<br>US 4994097 A<br>US 5073177 A   | 15/06/90<br>00/00/00<br>31/07/91<br>29/05/89<br>10/02/98<br>17/10/88<br>19/02/91<br>17/12/91   |
| WO 9423823 A1                             | 27/10/94            | AT 162418 T<br>AU 675535 B<br>AU 6658894 A<br>BR 9406173 A<br>CA 2160576 A<br>CN 1041282 B<br>CN 1124462 A<br>CZ 285941 B<br>CZ 9502686 A<br>DE 69408131 D,T<br>EP 0693958 A,B<br>SE 0693958 T3<br>ES 2111303 T<br>NL 9300651 A<br>US 5667543 A | 15/02/98<br>06/02/97<br>08/11/94<br>09/01/96<br>27/10/94<br>23/12/98<br>12/06/96<br>15/12/99<br>12/06/96<br>07/05/98<br>31/01/96<br>01/03/98<br>16/11/94<br>16/09/97 |
| WO 9744117 A1                             | 27/11/97            | AU 2913797 A<br>NL 1003157 C  | 09/12/97<br>00/00/00   |
| US 5542402 A                              | 06/08/96            | DE 69602873 D,T<br>EP 0736673 A,B   | 14/10/99<br>09/10/96   |



# RECORD

## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

|  |                 |
|--|-----------------|
| For 1  | Office use only |
| International Application No. PCT/ SE 00 / 01394   |                 |
| International Filing Date 30-06-2000   |                 |
| Name of receiving Office and PCT International Application<br>The Swedish Patent Office<br>PCT International Application |                 |
| Applicant's or agent's file reference 55924-60630<br>(if desired) (12 characters maximum)                                |                 |

|   |  |   |
|---|--|---|
| <b>Box No. I</b>  | <b>TITLE OF INVENTION</b><br>Oil separator for small particles       |   |
| <b>Box No. II</b>   | <b>APPLICANT</b>   |   |
| Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)             |  | <input type="checkbox"/> This person is also inventor.<br>Telephone No.<br>Facsimile No.<br>Teleprinter No.   |
| Volvo Lastvagnar AB<br>SE-405 08 Göteborg<br>Sweden   |  |   |
| State (that is, country) of nationality: SE   |  | State (that is, country) of residence: SE   |
| This person is the applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box |  |   |
| <b>Box No. III</b>  | <b>FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)</b>             |   |
| Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)             |  | This person is:<br><input type="checkbox"/> applicant only<br><input checked="" type="checkbox"/> applicant and inventor<br><input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.) |
| Håkansson, Nils Olof<br>Flintakroken 12<br>SE-443 60 Stenkullen<br>Sweden   |  |   |
| State (that is, country) of nationality: SE   |  | State (that is, country) of residence: SE   |
| This person is the applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box |  |   |
| <input type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet.   |  |   |
| <b>Box No. IV</b>   | <b>AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE</b> |   |
| The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:  |  | <input checked="" type="checkbox"/> agent <input type="checkbox"/> common representative  |
| Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)  |  | Telephone No.<br>Facsimile No.<br>Teleprinter No.   |
| HELLBOM L; BERG S A; FAGERLIN H; HAMMAR E;<br>LETTSTRÖM R; KIERKEGAARD, L-O; LAGMAN, S;<br>ALBIHNS PATENTBYRÅ STOCKHOLM AB, P.O. Box 5581,<br>S-114 85 STOCKHOLM, Sweden  |  | +46 8 59 88 72 00<br>+46 8 59 88 73 00<br>11942 ALBIHNS S   |
| <input type="checkbox"/> Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.  |  |   |

04-09-2000

| Continuation of Box No. III <b>FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)</b>  |   |
|---|---|
| <i>If none of the following sub-boxes is used, this sheet is not to be included in the request.</i>   |   |
| <p>Name and address: <i>Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.</i></p> <p style="text-align: center;">Persson, Per<br/>Fornfyndsvägen 18<br/>SE-433 41 Partille<br/>Sweden</p> | <p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input checked="" type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i></p> |
| State (i.e. country) of nationality: SE   | State (i.e. country) of residence: SE   |
| <p>This person is the applicant for the purposes of:    <input type="checkbox"/> all designated States    <input type="checkbox"/> all designated States except the United States of America    <input checked="" type="checkbox"/> the United States of America only    <input type="checkbox"/> the States indicated in the Supplemental Box</p>  |   |
| <p>Name and address: <i>Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.</i></p>   | <p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i></p>            |
| State (i.e. country) of nationality:  | State (i.e. country) of residence:  |
| <p>This person is the applicant for the purposes of:    <input type="checkbox"/> all designated States    <input type="checkbox"/> all designated States except the United States of America    <input type="checkbox"/> the United States of America only    <input type="checkbox"/> the States indicated in the Supplemental Box</p>   |   |
| <p>Name and address: <i>Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.</i></p>   | <p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i></p>            |
| State (i.e. country) of nationality:  | State (i.e. country) of residence:  |
| <p>This person is the applicant for the purposes of:    <input type="checkbox"/> all designated States    <input type="checkbox"/> all designated States except the United States of America    <input type="checkbox"/> the United States of America only    <input type="checkbox"/> the States indicated in the Supplemental Box</p>   |   |
| <p>Name and address: <i>Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.</i></p>   | <p>This person is:</p> <p><input type="checkbox"/> applicant only</p> <p><input type="checkbox"/> applicant and inventor</p> <p><input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i></p>            |
| State (i.e. country) of nationality:  | State (i.e. country) of residence:  |
| <p>This person is the applicant for the purposes of:    <input type="checkbox"/> all designated States    <input type="checkbox"/> all designated States except the United States of America    <input type="checkbox"/> the United States of America only    <input type="checkbox"/> the States indicated in the Supplemental Box</p>   |   |
| <p><input type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet.</p>  |   |



**Box No. V DESIGNATION OF STATES**

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):  
**Regional Patent**

- ☒ **AP** **ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting state of the Harare Protocol and of the PCT
- ☒ **EA** **Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP** **European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is Contracting State of the European Patent Convention and of the PCT
- ☒ **OA** **OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line) .....

**National Patent** (if other kind of protection or treatment desired, specify on dotted line):

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> <b>AE</b> United Arab Emirates.....                   | <input checked="" type="checkbox"/> <b>LR</b> Liberia .....                                  |
| <input checked="" type="checkbox"/> <b>AL</b> Albania.....                                | <input checked="" type="checkbox"/> <b>LS</b> Lesotho .....                                  |
| <input checked="" type="checkbox"/> <b>AM</b> Armenia.....                                | <input checked="" type="checkbox"/> <b>LT</b> Lithuania .....                                |
| <input checked="" type="checkbox"/> <b>AT</b> Austria.....                                | <input checked="" type="checkbox"/> <b>LU</b> Luxembourg .....                               |
| <input checked="" type="checkbox"/> <b>AU</b> Australia.....                              | <input checked="" type="checkbox"/> <b>LV</b> Latvia .....                                   |
| <input checked="" type="checkbox"/> <b>AZ</b> Azerbaijan .....                            | <input checked="" type="checkbox"/> <b>MA</b> Morocco .....                                  |
| <input checked="" type="checkbox"/> <b>BA</b> Bosnia and Herzegovina.....                 | <input checked="" type="checkbox"/> <b>MD</b> Republic of Moldova .....                      |
| <input checked="" type="checkbox"/> <b>BB</b> Barbados .....                              | <input checked="" type="checkbox"/> <b>MG</b> Madagascar .....                               |
| <input checked="" type="checkbox"/> <b>BG</b> Bulgaria.....                               | <input checked="" type="checkbox"/> <b>MK</b> The former Yugoslav Republic of Macedonia..... |
| <input checked="" type="checkbox"/> <b>BR</b> Brazil.....                                 | <input checked="" type="checkbox"/> <b>MN</b> Mongolia .....                                 |
| <input checked="" type="checkbox"/> <b>BY</b> Belarus .....                               | <input checked="" type="checkbox"/> <b>MW</b> Malawi.....                                    |
| <input checked="" type="checkbox"/> <b>CA</b> Canada .....                                | <input checked="" type="checkbox"/> <b>MX</b> Mexico .....                                   |
| <input checked="" type="checkbox"/> <b>CH and LI</b> Switzerland and Liechtenstein .....  | <input checked="" type="checkbox"/> <b>NO</b> Norway .....                                   |
| <input checked="" type="checkbox"/> <b>CN</b> China.....                                  | <input checked="" type="checkbox"/> <b>NZ</b> New Zealand .....                              |
| <input checked="" type="checkbox"/> <b>CR</b> Costa Rica .....                            | <input checked="" type="checkbox"/> <b>PL</b> Poland.....                                    |
| <input checked="" type="checkbox"/> <b>CU</b> Cuba.....                                   | <input checked="" type="checkbox"/> <b>PT</b> Portugal.....                                  |
| <input checked="" type="checkbox"/> <b>CZ</b> Czech Republic.....                         | <input checked="" type="checkbox"/> <b>RO</b> Romania .....                                  |
| <input checked="" type="checkbox"/> <b>DE</b> Germany.....                                | <input checked="" type="checkbox"/> <b>RU</b> Russian Federation.....                        |
| <input checked="" type="checkbox"/> <b>DK</b> Denmark.....                                | <input checked="" type="checkbox"/> <b>SD</b> Sudan .....                                    |
| <input checked="" type="checkbox"/> <b>DM</b> Dominica .....                              | <input checked="" type="checkbox"/> <b>SE</b> Sweden .....                                   |
| <input checked="" type="checkbox"/> <b>EE</b> Estonia.....                                | <input checked="" type="checkbox"/> <b>SG</b> Singapore .....                                |
| <input checked="" type="checkbox"/> <b>ES</b> Spain .....                                 | <input checked="" type="checkbox"/> <b>SI</b> Slovenia .....                                 |
| <input checked="" type="checkbox"/> <b>FI</b> Finland .....                               | <input checked="" type="checkbox"/> <b>SK</b> Slovakia .....                                 |
| <input checked="" type="checkbox"/> <b>GB</b> United Kingdom .....                        | <input checked="" type="checkbox"/> <b>SL</b> Sierra Leone .....                             |
| <input checked="" type="checkbox"/> <b>GD</b> Grenada .....                               | <input checked="" type="checkbox"/> <b>TJ</b> Tajikistan .....                               |
| <input checked="" type="checkbox"/> <b>GE</b> Georgia.....                                | <input checked="" type="checkbox"/> <b>TM</b> Turkmenistan.....                              |
| <input checked="" type="checkbox"/> <b>GH</b> Ghana.....                                  | <input checked="" type="checkbox"/> <b>TR</b> Turkey.....                                    |
| <input checked="" type="checkbox"/> <b>GM</b> Gambia .....                                | <input checked="" type="checkbox"/> <b>TT</b> Trinidad and Tobago.....                       |
| <input checked="" type="checkbox"/> <b>HR</b> Croatia .....                               | <input checked="" type="checkbox"/> <b>TZ</b> United Republic of Tanzania .....              |
| <input checked="" type="checkbox"/> <b>HU</b> Hungary.....                                | <input checked="" type="checkbox"/> <b>UA</b> Ukraine .....                                  |
| <input checked="" type="checkbox"/> <b>ID</b> Indonesia .....                             | <input checked="" type="checkbox"/> <b>UG</b> Uganda.....                                    |
| <input checked="" type="checkbox"/> <b>IL</b> Israel .....                                | <input checked="" type="checkbox"/> <b>US</b> United States of America .....                 |
| <input checked="" type="checkbox"/> <b>IN</b> India .....                                 | <input checked="" type="checkbox"/> <b>UZ</b> Uzbekistan .....                               |
| <input checked="" type="checkbox"/> <b>IS</b> Iceland .....                               | <input checked="" type="checkbox"/> <b>VN</b> Viet Nam.....                                  |
| <input checked="" type="checkbox"/> <b>JP</b> Japan .....                                 | <input checked="" type="checkbox"/> <b>YU</b> Yugoslavia .....                               |
| <input checked="" type="checkbox"/> <b>KE</b> Kenya .....                                 | <input checked="" type="checkbox"/> <b>ZA</b> South Africa .....                             |
| <input checked="" type="checkbox"/> <b>KG</b> Kyrgyzstan.....                             | <input checked="" type="checkbox"/> <b>ZW</b> Zimbabwe .....                                 |
| <input checked="" type="checkbox"/> <b>KP</b> Democratic People's Republic of Korea ..... | Check boxes reserved for designating States which have become                                |
| <input checked="" type="checkbox"/> <b>KR</b> Republic of Korea .....                     | Party to the PCT after issuance of this sheet:   |
| <input checked="" type="checkbox"/> <b>KZ</b> Kazakstan .....                             | <input checked="" type="checkbox"/> <b>DZ</b> Algeria.....                                   |
| <input checked="" type="checkbox"/> <b>LC</b> Saint Lucia .....                           | <input checked="" type="checkbox"/> <b>AG</b> Antigua & Barbuda.....                         |
| <input checked="" type="checkbox"/> <b>LK</b> Sri Lanka .....                             | <input checked="" type="checkbox"/> <b>MZ</b> Mozambique .....                               |
|   | <input checked="" type="checkbox"/> <b>BZ</b> Belize .....                                   |

**Precautionary Designation Statement:** In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)

30-06-2000

Sheet No. 3


| <b>Box No. VI PRIORITY CLAIM</b>                          |                                  | <input type="checkbox"/> Further priority claims are indicated in the Supplemental Box |  |   |
|---|----------------------------------|--|--|---|
| Filing date<br>of earlier application<br>(day/month/year) | Number<br>of earlier application | Where earlier application is:  |  |   |
|   |                                  | national application:<br>country:  | regional<br>application:*<br>regional Office | international<br>application:<br>receiving Office |
| item (1)<br>30 June 1999                                  | 9902490-3                        | Sweden   |  |   |
| item (2)  |                                  |  |  |   |
| item (3)  |                                  |  |  |   |

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): (1)

\* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See supplemental Box.

|   |  |  |                                     |
|---|--|--|-------------------------------------|
| <b>Box No. VII INTERNATIONAL SEARCHING AUTHORITY</b>  |  |  |                                     |
| Choice of International Searching Authority (ISA) (If two or more international Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used): |  | Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority): |                                     |
| ISA /SE   |  | Date (day/month/year):   | Number Country (or regional Office) |
|   |  | 30 June 1999   | 99/00926 SE                         |

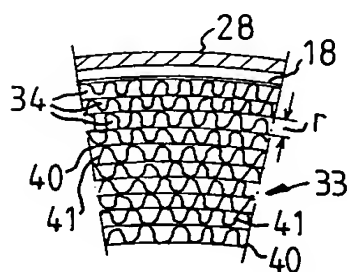
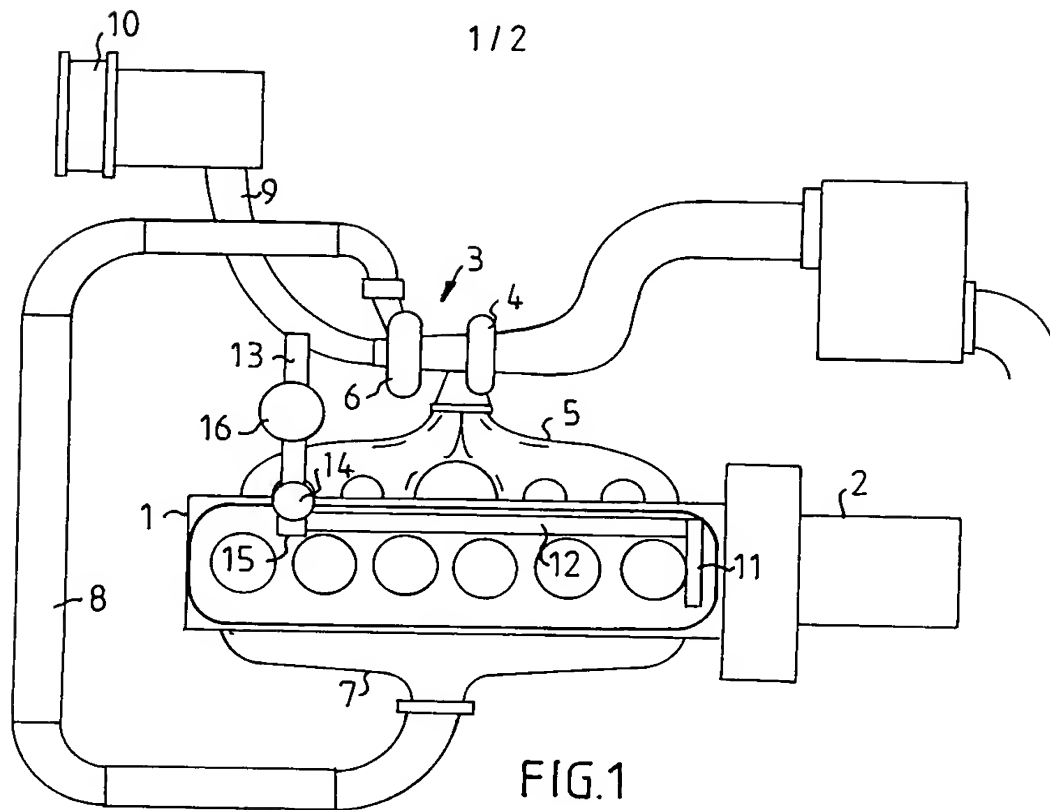
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| <b>Box No. VIII CHECK LIST; LANGUAGE OF FILING</b>  |  |
| This international application contains the following number of sheets:<br>request: 3 ✓<br>description (excluding sequence listing part): 5 ✓<br>claims: 2 ✓<br>abstract: 1 ✓<br>drawings: 2 ✓<br>sequence listing part of description: _____<br>Total number of sheets: 13 | This international application is accompanied by the item(s) marked below:<br>1. <input type="checkbox"/> fee calculation sheet<br>2. <input type="checkbox"/> separate signed power of attorney<br>3. <input checked="" type="checkbox"/> copy of general power of attorney; reference number, if any: 4367/98<br>4. <input type="checkbox"/> statement explaining lack of signature<br>5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s):<br>6. <input type="checkbox"/> translation of international application into (language):<br>7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material<br>8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form<br>9. <input checked="" type="checkbox"/> other (specify): Copy of ITS report |
| Figure of the drawings which should accompany the abstract: 2   | Language of filing of the international application: Swedish   |

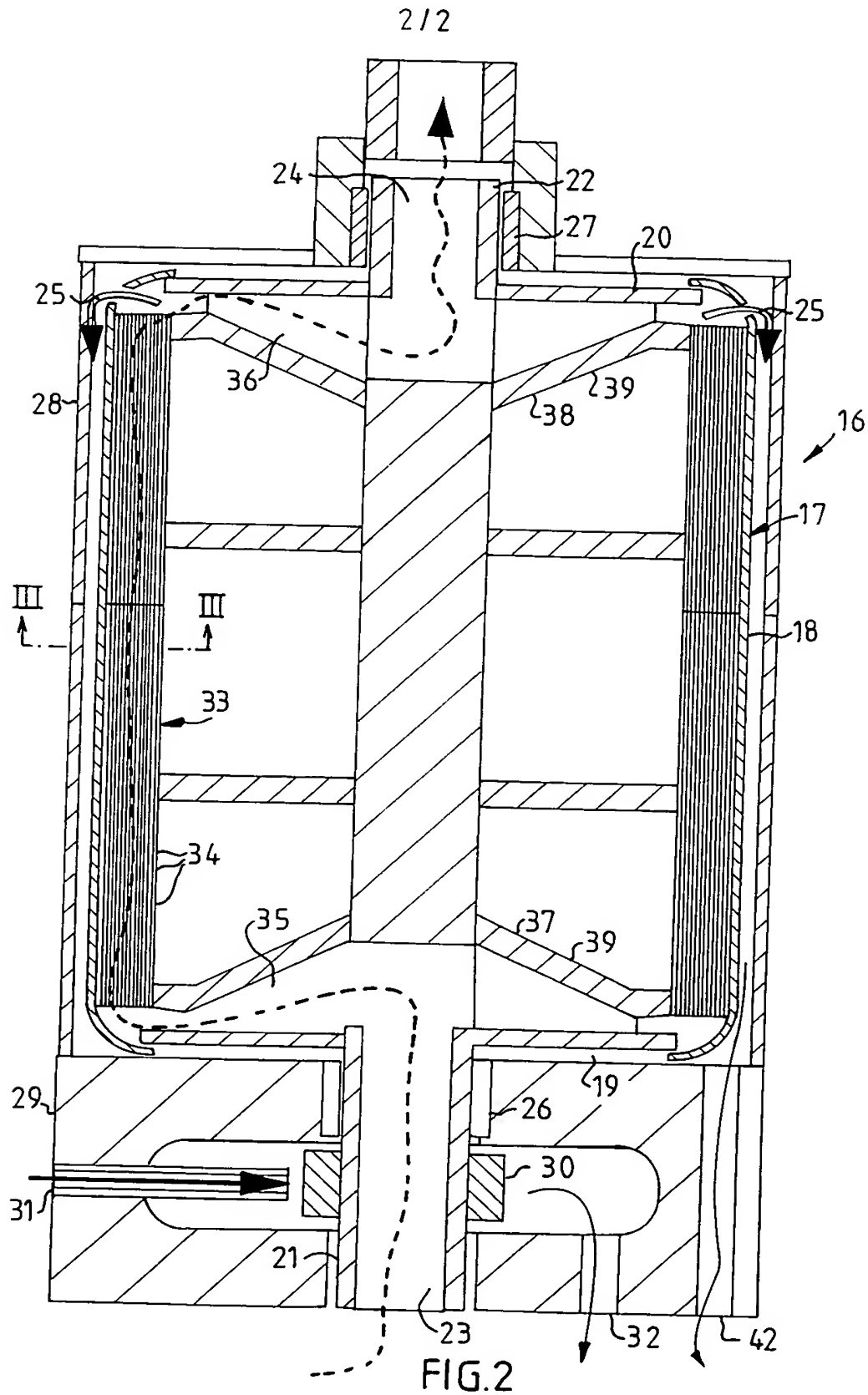
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| <b>Box No. IX SIGNATURE OR APPLICANT OR AGENT</b>  |  |
| Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request). |  |
| <br>Lars Hellborn   |  |

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| 1. Date of actual receipt of the purported international application: _____<br>3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application: _____<br>4. Date of timely receipt of the required corrections under PCT-Article 11(2): _____<br>5. International Searching Authority (if two or more are competent): ISA/ SE | For receiving Office use only<br>30-06-2000<br>2. Drawings:<br><input checked="" type="checkbox"/> received:<br><input type="checkbox"/> not received:<br>6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid |
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25-08-2000





## Oljeavskiljare för små partiklar

Föreliggande uppfinning avser en anordning för att avskilja små vätskedroppar ur en strömmande gas innehållande vätskedimma, t ex små oljedroppar ur sk blow-by gas från en förbränningsmotor, innefattande en av en cylindrisk mantel och två motstående gavlar bildad första behållare med ett inlopp i sin ena gavel för gasen/dimman, ett första utlopp i sin andra gavel för gasen samt ett andra utlopp i eller i närheten av den andra gaveln för ur gasen avskild vätska, en andra behållare med organ för att roterbart lagra den första behållaren i den andra behållaren rotationssymmetriskt i förhållande till nämnda inlopp och första utlopp samt drivorgan för rotation av den första behållaren i den andra behållaren.

Det är ett känt faktum att det inte går att åstadkomma kolvringtätningar mellan kolvarna och de omgivande cylinderväggarna hos cylindrarna i en förbränningsmotor, som till hundra procent avtätar förbränningsrummen mot motorns vevhus. En viss mindre mängd förbränningsgaser, här kallad blow-by gas, strömmar därför alltid förbi kolvringarna och ned i motorns vevhus. För att inte ett för högt övertryck orsakat av blow-by gaserna skall uppstå i vevhuset måste vevhuset ventileras, så att gaserna leds bort och endast ett lågt övertryck tillåts råda i vevhuset.

Två typer av vevhusventilation förekommer, nämligen antingen öppen eller sluten ventilation. En motor med öppen ventilation kan helt enkelt ha ett till en öppning i motorn, t ex i ventilkåpan, anslutet nedåtriktat rör, som mynnar i den omgivande atmosfären. I en motor med sluten vevhusventilation leds blow-by gaserna från vevhuset till motorns insugningsrör och blandas med insugningsluften.

Vid evakueringen av blow-by gaserna har det hittills varit ofrånkomligt att en viss mängd oljedimma följer med ut. Mängden olja som följer med gasen beror på placeringen av ventilationsutloppet och eventuella befintliga filter eller oljefällor i vevhusventilationen. Oavsett om motorn har öppen eller sluten vevhusventilation är det ett önskemål att hålla mängden olja i den evakuerade blow-by gasen så liten som

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möjligt. I det första fallet för att miljöpåverkan ska bli så liten som möjligt och för att hålla motorns oljeförbrukning på en låg nivå. I det andra fallet för att hindra oljebeläggning eller -ansamling på resp. i komponenter i motorns insugningssystem, t ex oljebeläggning på skovelbladen i en turboladdad motors kompressor resp. ansamling av olja i laddluftkylaren i motorer med laddluftkylning.

Ett flertal olika anordningar för att avskilja olja ur blow-by gaserna från förbränningsmotorer är kända. Bland dessa kan nämnas olika typer av baffel- och skärmsystem, metalltråds- eller textilfiberfilter samt cykloner och centrifuger. Med hjälp av baffel-och skärmsystem har man hittills kunnat avskilja oljedroppar ned till en diameter på ca 10 $\mu$ m, med metalltrådsfilter och cykloner ned till ca 1,5  $\mu$ m och med flerskikts textilfiberfilter, t ex fliesfilter ned till ca 0,4  $\mu$ m. Baffel- och skärmsystemen har i princip obegränsad livslängd och ger inga tryckförluster men åstadkommer inte tillräckligt effektiv oljeavskiljning, eftersom ca 80% av oljemassan hos oljedimman i blow-by gaserna består av oljedroppar med en diameter, som är mindre än 1,5 $\mu$ m. Följaktligen räcker inte heller hittills kända metalltrådsfilter och cykloner, som trots allt har acceptabel livlängd och ger begränsade tryckförluster, för att uppnå en effektiv oljeavskiljning. Då återstår flerskikts fliesfilter, men dessa har begränsad livslängd och måste därför bytas ofta, vilket leder till höga kostnader. De ger dessutom stora tryckförluster.

Syftet med föreliggande uppfinning är att åstadkomma en anordning av i inledningen angivet slag, dvs en avskiljare av centrifugtyp, som är särskilt men inte uteslutande avsedd för avskiljning av oljedimdroppar ur blow-by gaser från förbränningsmotorer och som kan avskilja vätskedroppar mindre än 1 $\mu$ m utan att vara behäftad med nackdelarna hos exempelvis ett flerskikts fliesfilter.

Detta uppnås enligt uppfinningen genom att inloppet och utloppen kommunicerar med varandra via i flera lager periferiellt fördelade, i rotationsaxelriktningen förlöpande och på radiellt avstånd från rotationsaxeln belägna smala kanaler, vars radiella

dimension är så avpassad till deras längd, radiella avstånd till rotationsaxeln, gasens strömningshastighet samt rotationshastigheten, att åtminstone merparten av vätskedropparna i dimman hinner avsättas på kanalernas väggar innan de når utloppet.

- 5 Utförda försök har härvid visat att i ett föredraget utförande särskilt avsett för avskiljning av oljedimma ur blow-by gaser kunde med lämplig val av ovannämnda parametrar mer än 90% av all oljedimma i gaserna avskiljas. Gashastigheten, sträckan, som oljedropparna måste förflytta sig radiellt utåt för att träffa kanalväggen, och accelerationen radiellt bestämmer härvid erforderlig uppehållstid för dropparna i kanalerna. Denna tid bestämmer i sin tur erforderlig kanallängd. Det har härvid visat sig att diametern (hos cirkulära kanaler) inte bör överstiga utan snarare understiga 1mm för att avskiljaren skall få rimliga dimensioner och rimligt varvtal.

- 15 Uppfinningen beskrives närmare med hänvisning till på bifogade ritningar visade utföringsexempel, där fig. 1 visar en schematisk framställning av en motorinstallation med en anordning enligt uppfinningen, fig. 2 ett schematiskt längdsnitt genom en utföringsform av en anordning enligt uppfinningen och fig. 3 ett förstorat delsnitt utefter linjen III-III i fig. 2.

- 20 I fig. 1 betecknar 1 motorblocket till en sexcylindrig fyrtakts dieselmotor och 2 en till motorns vevaxel ansluten växellåda med koppling. Motorn är överladdad av en turbokompressor 3, som har en turbin 4 ansluten till motorns avgasgrenrör 5 och en kompressor 6 ansluten till dess insugningsgrenrör 7 via en laddluftkylare 8. Kompressorns 6 sug sida är via en insugningsledning 9 ansluten till ett luftfilter 10.

- 25 I motorns 1 vevhus är en i och för sig känd och endast scematiskt antydd skärmavskiljare 11 och baffelavskiljare 12 anordnad. En ledning 13 med en tryckregleringsventil 14 och tryckavkännare 15 förbinder motorns vevhus med insugningsledningen 9 via en oljedimavskiljare 16 enligt uppfinningen, vilken visas närmare i fig. 2.

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Avskiljaren 16 innefattar en inre behållare 17, som är bildad av en cylindrisk mantel 18 och två gavelstycken 19 och 20, som uppvisar varsin central öppning, i vilka en röraxel 21 resp. 22 är fixerad. Röraxelns 21 kanal 23 bildar ett inlopp för förbränningsgaser och oljedimma, medan röraxelns 22 kanal 24 bildar ett utlopp för avgas-  
5 ser. Periferiellt fördelade öppningar 25 i manteln 18 bildar utlopp för avskild olja. Röraxlarna 21, 22 är lagrade i lager 26, 27 hos en stationär yttre behållare 28, som har en nedre del 29, vilken bildar ett turbinhus. Den nedre röraxeln 21 sträcker sig genom turbinhuset 29 och uppbär ett turbinhjul 30. Huset 29 har ett inlopp 31 och ett utlopp 32 för olja från motorns smörjoljesystem. När motorn är igång och  
10 smörjolja pumpas genom huset 29 driver turbinhjulet 30 axeln 21, så att den inre behållaren 17 roterar i den yttre behållaren 28.

Mot insidan av den inre behållarens 17 mantel 18 är ett cylindriskt paket 33 bestående av flera lager av axiella kanaler 34 fixerat. Man kan även tänka sig att integrera  
15 den cylindriska manteln 18 i kanalpaketet 34. Kanalerna 34 är öppna i sina ändar och kommunicerar med radiella passager 35, 36 vilka är avgränsade mellan respektive gavelstycke 19, 20, ett par koniska väggelement 37, 38 och mellanliggande radiellt riktade, periferiellt jämnt fördelade mellanväggar 39. En förstorad del av ett kanalpaket 33 med tio lager visas i tvärsnitt i fig. 3. Kanalerna 34 är här kraftigt försto-  
20 rade. I praktiska försök med ett innerbehållarutförande med en kanallängd av ca 200 mm, en innerbehållarradie av ca 100 mm och ett varvtal på ca 3000 rpm visade det sig att kanalernas radiella dimension "r" skulle ligga strax under 1 mm för att de minsta oljedropparna skulle hinna träffa kanalväggarna innan gaserna hade strömmat igenom kanalerna och ut i utloppspassagerna 36.

Hos det i fig. 3 visade utföringsexemplet är kanalerna 34 i kanalpaketet 33 bildade av omväxlande släta och veckade plåt cylindrar 40 resp. 41, dvs motsvarande upp-  
byggnaden av wellpapp. Kanalpaketet kan även vara en massiv kropp, t ex en kera-  
mikkropp, med borrar eller gjutna cylindriska kanaler. Kanalpaketets utbredning i  
30 radiell led uppgår företrädesvis till ca 20% av den första behållarens radie. Vid större utbredning riskerar de radiellt inre kanalerna att hamna så nära rotationsaxeln, att



centrifugalkraften på de minsta dropparna blir för låg för att de skall hinna accelerera ut till kanalväggen.

5 Oljan, som transporteras av förbränningsgaserna genom kanalerna 34 och under inverkan av centrifugalkraften vid den inre behållarens rotation träffar kanalväggarna, kastas ut genom öppningarna 25, såsom antyds med de heldragna pilarna, och rinner ned i mellanrummet mellan behållarna till ett utlopp 42. Därifrån leds oljan tillbaka till motorns vevhus. De från oljedimman befriade förbränningsgaserna utströmmar genom den övre röraxeln 22, såsom antyds med den streckade pilen.

**Patentkrav**

1. Anordning för att avskilja små vätskedroppar ur en strömmande gas innehållande vätskedimma, innefattande en av en cylindrisk mantel (18) och två motstående gav-  
5 lar (19,20) bildad första behållare (17) med ett inlopp (23) i sin ena gavel för gasen/dimman, ett första utlopp (24) i sin andra gavel för gasen samt ett andra utlopp (25) i eller i närheten av den andra gaveln för ur gasen avskild vätska, en andra behållare (28) med organ (26,27) för att roterbart lagra den första behållaren i den andra behållaren rotationssymmetriskt i förhållande till nämnda inlopp och första  
10 utlopp samt drivorgan (30) för rotation av den första behållaren i den andra behållaren, kännetecknad av att inloppet (23) och utloppen (24,25) kommunicerar med varandra via i flera lager periferiellt fördelade, i rotationsaxelriktningen förlöpande och på radiellt avstånd från rotationsaxeln belägna smala kanaler (34), vars radiella dimension ( $r$ ) är så avpassad till deras längd, radiella avstånd till rotationsaxeln, gasens strömningshastighet samt rotationshastigheten, att åtminstone merparten av  
15 vätskedropparna i dimman hinner avsättas på kanalernas väggar innan de når utloppet.
2. Anordning enligt krav 1, kännetecknad av att inloppet (23) har en koncentriskt  
20 med den första behållarens rotationsaxel placerad inloppsöppning, som mynnar i ett flertal radiella inloppspassager (35), vilka leder ut till inlopp hos kanalerna (34), och att kanalerna har utlopp, som mynnar dels i ett flertal radiella utloppspassager (36), genom vilka gasen kan strömma in till en koncentriskt med nämnda rotationsaxel placerad utloppsöppning (24), och dels i ett flertal utloppsöppningar (25), genom  
25 vilka under inverkan av centrifugalkraften på kanalernas väggar avsatt vätska kan strömma radiellt utåt till ett utrymme mellan den första och den andra behållaren.
3. Anordning enligt krav 2, kännetecknad av att behållarna (17,28) är orienterade  
30 med rotationsaxeln vertikalt, så att avskild vätska under tyngdkraftens inverkan kan strömma till inloppsändan och ut genom ett vätskeutlopp (42) från den andra behållaren (28).

4. Anordning enligt krav 2 eller 3, kännetecknad av att gavlarna har två på axiellt avstånd från varandra placerade väggar (19,37 resp 20,38), som tillsammans med mellanliggande radiellt riktade väggpartier (39) avgränsar nämnda passager (35,36).
- 5 5. Anordning enligt något av kraven 1-4, kännetecknad av att drivorganen är bildade av en väsketurbin (30).
6. Anordning enligt krav 5, kännetecknad av att gavlarna (19,20) är förbundna med roterbart lagrade ihåliga axlar (21,22), vars inre bildar en inlopps- resp utloppskanal (23 resp 24) och att ett turbinhjul (30) är fixerat på den ena axeln.
- 10 7. Anordning enligt något av kraven 1-6, kännetecknad av att kanallagrens utbredning i radiell led uppgår till ca 20% av den första behållarens (17) radie.
- 15 8. Anordning enligt något av kraven 1-7, kännetecknad av att den första behållarens (17) inlopp (23) är förbundet med en ventilationsledning från ett vevhus hos en förbränningsmotor (1) och dess utlopp (24) med en insugningsluftledning till motorn.
- 20 9. Anordning enligt krav 8, kännetecknad av att den första behållarens (17) radie är ca 100 mm och dess längd ca 200 mm, att behållaren är avsedd att drivas med ett varvtal av ca 3000 rpm, att kanalernas (34) radiella dimension (r) är mindre än 1 mm och att det yttersta kanallagret är beläget på maximalt radiellt avstånd från rotationsaxeln.

## Sammandrag

Anordning för att avskilja oljedimma ur blow-by gaser från en förbränningsmotor, innefattande en roterande cylindrisk behållare (17) med ett centralt inlopp (23) för gaser med oljedimma vid sin ena ände samt ett centralt utlopp (24) för gaser och perifer utlopp (25) för avskild olja vid den andra änden. Mellan inloppet och utloppen sträcker sig smala kanaler (34) i flera lager på avstånd från rotationsaxeln, genom vilka gasen med oljedropparna strömmar. Under inverkan av centrifugalkraften transporteras oljedropparna samtidigt radiellt, varvid varvtalet, kanalernas längd och radiella dimension är så avpassade till varandra, att oljedropparna hinner träffa kanalväggarna innan de utströmmar ur kanalerna.

(fig. 2)

# Claims

1. Device for separating small drops of liquid from a flowing gas, containing liquid mist, comprising a first container (17), formed of a cylindrical lateral wall (18) and two opposite end walls (19, 20), said first container having an inlet (23) in one end wall for the gas/mist, a first outlet (24) in its other end wall for the gas and a second outlet (25) at or in the vicinity of the second end wall for liquid separated out of the gas, a second container (28) with means (26, 27) for rotatably mounting the first container in the second container rotationally symmetrically in relation to said inlet and said first outlet, and drive means (30) for rotation of the first container in the second container, characterized in that the inlet (23) and the outlets (24, 25) communicate with each other via a plurality of layers of peripherally spaced, narrow channels (34) extending in the direction of the rotational axis and being disposed at a radial distance from the rotational axis, said narrow channels having a radial dimension (r) being adapted to their length, their radial distance to the rotational axis, the flow velocity of the gas and the rotational speed, so that at least the major portion of the liquid drops in the mist will have time to be deposited on the channel walls before they reach the outlet.
2. Device according to claim 1, characterized in that the inlet (23) has an inlet opening placed concentrically with the rotational axis of the first container, said inlet opening leading to a plurality of radial inlet passages (35) leading out to inlets of the channels (34), and that the channels have outlets opening, firstly, into a plurality of radial outlet passages (36), through which the gas can flow into an outlet opening (24) placed concentrically with said rotational axis, and, secondly, into a plurality of outlet openings (25), through which liquid deposited under the effect of the centrifugal force on the walls of the channels, can flow radially outwards to a space between the first container and the second container.
3. Device according to claim 2, characterized in that the containers (17, 28) are oriented with the rotational axis vertical so that liquid separated out can flow,

by the force of gravity, to the inlet end and out through a liquid outlet (42) from the second container (28).

4. Device according to claim 2 or 3, characterized in that the end walls have two axially spaced walls (19, 37 and 20, 38, respectively) which, together with intermediate radially directed wall portions (39), define said passages (35, 36).
5. Device according to one of claims 1-4, characterized in that the drive means are formed by a liquid turbine (30).
6. Device according to claim 5, characterized in that the end walls (19, 20) are joined to rotatably mounted hollow shafts (21, 22), the interiors of which forming inlet and outlet channels, respectively (23 and 24, respectively), and in that a turbine wheel (30) is fixed to one of said shafts.
7. Device according to one of claims 1-6, characterized in that the extent of the channel layers radially amounts to circa 20% of the radius of the first container (17).
8. Device according to one of claims 1-7, characterized in that the inlet (23) of the first container (17) is joined to a ventilation conduit from a crankcase of an internal combustion engine (1), and its outlet (24) is joined to an inlet air conduit to the engine.
9. Device according to claim 8, characterized in that the radius of the first container (17) is circa 100 mm and its length circa 200 mm, that the container is designed to be driven at a rotational speed of circa 3 000 rpm, that the radial dimension (r) of the channels (34) is less than 1 mm, and that the outermost channel layer is located at a maximum radial distance from the rotational axis.

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

|   |   |   |
|---|---|---|
| Applicant's or agent's file reference<br>55924-60630  | <b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |   |
| International application No.<br>PCT/SE00/01394   | International filing date ( <i>day/month/year</i> )<br>30.06.2000   | Priority date ( <i>day/month/year</i> )<br>30.06.1999 |
| International Patent Classification (IPC) or national classification and IPC<br>F01M 13/04, B01D 45/14, B04B 5/08 |   |   |
| Applicant<br>Volvo Lastvagnar AB et al  |   |   |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

|   |  |
|---|--|
| Date of submission of the demand<br><br>18.01.2001  | Date of completion of this report<br><br>26.09.2001                              |
| Name and mailing address of the IPEA/SE<br>Patent- och registreringsverket      Telex<br>Box 5055                                      17978<br>S-102 42 STOCKHOLM                      PATOREG-S<br>Facsimile No. 08-667 72 88 | Authorized officer<br><br>Jan-Axel Ylivainio / MRO<br>Telephone No. 08-782 25 00 |

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/01394

## I. Basis of the report

## 1. With regard to the elements of the international application:\*

- ☐ the international application as originally filed
- ☒ the description:  
pages 1-5, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☒ the claims:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, as amended (together with any statement) under article 19  
pages \_\_\_\_\_, filed with the demand  
pages 6-7, filed with the letter of 18.06.2001
- ☒ the drawings:  
pages 1-2, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

## 2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

## 3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.



## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/01394

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

|                               |        |            |     |
|-------------------------------|--------|------------|-----|
| Novelty (N)                   | Claims | <u>1-8</u> | YES |
|                               | Claims |            | NO  |
| Inventive step (IS)           | Claims | <u>1-8</u> | YES |
|                               | Claims |            | NO  |
| Industrial applicability (IA) | Claims | <u>1-8</u> | YES |
|                               | Claims |            | NO  |

**2. Citations and explanations (Rule 70.7)**

## Cited documents:

A: EP 0286160 A1  
B: WO 9423823 A1  
C: WO 9744117 A1  
D: US 5542402 A

The claimed invention relates to a device for separating small droplets of liquid from a flowing gas containing liquid mist.

The most relevant document, A, discloses a rotational particle separator according to the preamble of claim 1. The known separator can be applied to remove particulate matter from combustion gases produced in the burning of coal. The separator is particularly attractive in the case of removal of particulate matter from gases of high temperature or from corrosive gases, or particulate matter which is limited in electrostatic loadability.

The invention claimed in claim 1 differs from the known separator in that the inlet of a first container is joined to a ventilation conduit from a crankcase of an internal combustion engine, and its outlet is joined to an inlet air conduit to the engine.

The subject matter of claim 1, therefore, is novel and has industrial applicability.

With regard to the cited documents A-D, the subject matter of claim 1 is not obvious to a person skilled in the art and, therefore, also involves an inventive step.

Dependent claims 2-8 are acceptable in conjunction with claim 1.

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 10 OCT 2001

WIPO

PCT

|   |   |  |
|---|---|--|
| Applicant's or agent's file reference<br>55924-60630  | <b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |  |
| International application No.<br>PCT/SE00/01394   | International filing date (day/month/year)<br>30.06.2000  | Priority date (day/month/year)<br>30.06.1999 |
| International Patent Classification (IPC) or national classification and IPC<br>F01M 13/04, B01D 45/14, B04B 5/08 |   |  |
| Applicant<br>Volvo Lastvagnar AB et al  |   |  |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

|   |  |
|---|--|
| Date of submission of the demand<br><br>18.01.2001  | Date of completion of this report<br><br>26.09.2001                              |
| Name and mailing address of the IPEA/SE<br>Patent- och registreringsverket      Telex<br>Box 5055      17978<br>S-102 42 STOCKHOLM      PATOREG-S<br>Facsimile No. 08-667 72 88 | Authorized officer<br><br>Jan-Axel Ylivainio / MRO<br>Telephone No. 08-782 25 00 |

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/01394

## I. Basis of the report

## 1. With regard to the elements of the international application:\*

- ☐ the international application as originally filed
- ☒ the description:  
pages 1-5, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☒ the claims:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, as amended (together with any statement) under article 19  
pages \_\_\_\_\_, filed with the demand  
pages 6-7, filed with the letter of 18.06.2001
- ☒ the drawings:  
pages 1-2, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

## 2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

## 3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/01394

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

|                               |        |            |     |
|-------------------------------|--------|------------|-----|
| Novelty (N)                   | Claims | <u>1-8</u> | YES |
|                               | Claims |            | NO  |
| Inventive step (IS)           | Claims | <u>1-8</u> | YES |
|                               | Claims |            | NO  |
| Industrial applicability (IA) | Claims | <u>1-8</u> | YES |
|                               | Claims |            | NO  |

**2. Citations and explanations (Rule 70.7)**

## Cited documents:

A: EP 0286160 A1  
B: WO 9423823 A1  
C: WO 9744117 A1  
D: US 5542402 A

The claimed invention relates to a device for separating small droplets of liquid from a flowing gas containing liquid mist.

The most relevant document, A, discloses a rotational particle separator according to the preamble of claim 1. The known separator can be applied to remove particulate matter from combustion gases produced in the burning of coal. The separator is particularly attractive in the case of removal of particulate matter from gases of high temperature or from corrosive gases, or particulate matter which is limited in electrostatic loadability.

The invention claimed in claim 1 differs from the known separator in that the inlet of a first container is joined to a ventilation conduit from a crankcase of an internal combustion engine, and its outlet is joined to an inlet air conduit to the engine.

The subject matter of claim 1, therefore, is novel and has industrial applicability.

With regard to the cited documents A-D, the subject matter of claim 1 is not obvious to a person skilled in the art and, therefore, also involves an inventive step.

Dependent claims 2-8 are acceptable in conjunction with claim 1.

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4 January 2001 (04.01.2001)

PCT

(10) International Publication Number  
**WO 01/00969 A1**

(51) International Patent Classification<sup>7</sup>: **F01M 13/04**,  
B01D 45/14, B04B 5/08

(SE). PERSSON, Per [SE/SE]; Fornfyndsvägen 18,  
SE-433 41 Partille (SE).

(21) International Application Number: PCT/SE00/01394

(74) Agents: HELLBOM, L. et al.; Albihns Patentbyrå Stock-  
holm AB, P.O. Box 5581, S-114 85 Stockholm (SE).

(22) International Filing Date: 30 June 2000 (30.06.2000)

(25) Filing Language: Swedish

(26) Publication Language: English

(30) Priority Data:  
9902490-3 30 June 1999 (30.06.1999) SE

(71) Applicant (for all designated States except US): VOLVO  
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(72) Inventors; and

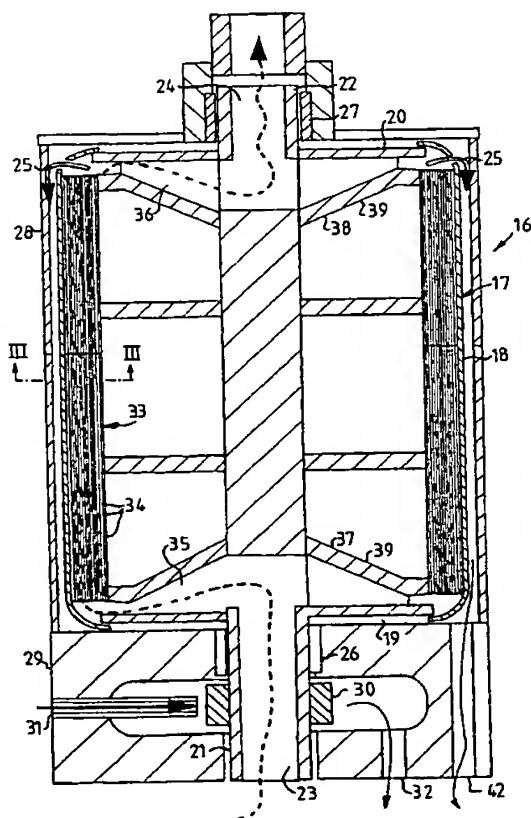
(75) Inventors/Applicants (for US only): HÅKANSSON,  
Nils, Olof [SE/SE]; Flintakroken 12, S-443 60 Stenkullen

(81) Designated States (national): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,  
DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR,  
HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,  
LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ,  
NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM,  
TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,  
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: OIL SEPARATOR FOR SMALL PARTICLES



(57) Abstract: Device for separating oil mist from blow-by-gases from an internal combustion engine, comprising a rotating cylindrical container (17) with a central inlet (23) for gases with oil mist at one end and a central outlet (24) for gases and peripheral outlets (25) for separated oil at the other end. Between the inlet and the outlet, narrow channels (34) extend in several layers, spaced from the axis of rotation, through which the gas with oil drops flows. Under the influence of the centrifugal force the drops of oil are moved at the same time radially, the rotational speed and the length and radial dimension of the channels being adapted to each other so that the oil drops strike the channel walls before flowing out of the channels.

WO 01/00969 A1



**Published:**

— With international search report.

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

### Oil separator for small particles

The present invention relates to a device for separating small drops of liquid from a flowing gas containing liquid mist, comprising a first container, formed of a cylindrical lateral wall and two opposite end walls, said first container having an inlet in one end wall for the gas/mist, a first outlet in its other end wall for the gas and a second outlet at or in the vicinity of the second end wall for liquid separated out of the gas, a second container with means for rotatably mounting the first container in the second container rotationally symmetrically in relation to said inlet and said first outlet, and drive means for rotation of the first container in the second container.

It is a known fact that it is not possible to achieve piston ring seals between the pistons and the surrounding cylinder walls of the cylinders in an internal combustion engine, which seal off the combustion chambers 100% against the engine crankcase. A certain small amount of combustion gases, called here blow-by gas, thus always flows past the piston rings and down into the engine crankcase. In order to prevent excessive pressure caused by the blow-by gas in the crankcase, the crankcase must be ventilated and the gas drawn off leaving only a low overpressure in the crankcase.

Two types of crankcase ventilation are used, viz. either open or closed ventilation. An engine with open ventilation can, quite simply, have a downwardly directed tube connected to the valve cover, for example, and which opens into the surrounding atmosphere. In an engine with closed crankcase ventilation, the blow-by gases from the crankcase are led to the engine intake conduit and are mixed with the intake air.

When evacuating blow-by gases, it has, up to now, been unavoidable that a certain amount of oil mist will accompany them. The amount of oil being carried with the gas depends on the placement of the ventilation outlet and any filters or oil traps in the crankcase ventilation. Regardless of whether the engine has open or closed crankcase ventilation, it is desirable to keep the amount of oil in the evacuated

blow-by gas at a minimum. In the first case, it is to minimize the effect on the environment and to keep the engine oil consumption at a low level. In the second case, it is to prevent oil deposits on or in the components of the engine intake system, e.g. oil deposits on the impeller blades of the compressor of a turbo-charged engine or oil deposits in the charge air cooler in engines with charge air cooling.

A number of different devices to separate oil from blow-by gases from internal combustion engines are known. Among them are various types of baffle or screen systems, metal wire or textile fibre filters as well as cyclones and centrifuges. With the aid of baffle and screen systems, it has up to now been possible to separate oil drops down to a diameter of circa 10  $\mu\text{m}$ , with metal wire filters and cyclones down to circa 1.5  $\mu\text{m}$  and with multi-layer textile fibre filters, e.g. fleece filters, down to circa 0.4  $\mu\text{m}$ . Baffle and screen systems have, in principle, an unlimited lifetime and do not produce any pressure losses, but do not provide sufficiently effective oil separation, since circa 80% of the oil mass in the oil mist in the blow-by gases consists of oil drops with a diameter which is less than 1.5  $\mu\text{m}$ . Previously known metal wire filters and cyclones thus are not sufficient either for achieving effective oil separation despite the fact that they have acceptable lifetimes and provide limited pressure losses. Multi-layer fleece filters remain, but these have limited lifetimes and therefore must be replaced often, leading to high costs. They also produce significant pressure losses.

The purpose of the present invention is to achieve a device of the type described by way of introduction, i.e. a separator of centrifugal type, which is particularly, but not exclusively, intended for separation of oil mist drops from blow-by gases from internal combustion engines and which can separate liquid drops of less than 1  $\mu\text{m}$  without having the disadvantage of a multi-layer fleece filter, for example.

This is achieved according to the invention by virtue of the fact that the inlet and the outlets communicate with each other via a plurality of layers of peripherally spaced,



narrow channels extending in the direction of the rotational axis and being disposed at a radial distance from the rotational axis, said narrow channels having a radial dimension being adapted to their length, their radial distance to the rotational axis, the flow velocity of the gas and the rotational speed, so that at least the major portion of the liquid drops in the mist will have time to be deposited on the channel walls before they reach the outlet.

Tests performed have demonstrated that in a preferred embodiment particularly designed for separating oil mist from blow-by gases, with a suitable selection of the above-mentioned parameters, more than 90% of all the oil mist in the gases was separated out. The gas velocity, the distance which the oil drops must move radially outwards to strike the channel wall, and the radial acceleration determine in this case the required length of stay for the drops in the channels. This length of stay determines in turn the required channel length. It has been shown that the diameter (of circular channels) should not exceed, but should preferably be less than 1 mm for the separator to have reasonable dimensions and a reasonable rotational speed.

The invention will be described in more detail below with reference to examples shown in the accompanying drawings, where Fig. 1 shows a schematic representation of an engine installation with a device according to the invention, Fig. 2 is a schematic longitudinal section through one embodiment of a device according to the invention, and Fig. 3 is an enlarged cross-section along the line III-III in Fig. 2.

1 in Fig. 1 designates the engine block of a six-cylinder, four-stroke diesel engine, and 2 designates a gearbox with clutch, coupled to the engine crankshaft. The engine is supercharged by a turbo compressor 3, which has a turbine 4 coupled to the engine exhaust manifold 5, and a compressor 6 coupled to the inlet manifold 7 via a charge air cooler 8. The suction side of the compressor 6 is coupled via an inlet conduit 9 to an air filter 10.

In the crankcase of the engine 1, a screen separator 11 and a baffle separator 12, known per se and only schematically indicated here, are arranged. A conduit 13 with a pressure regulator valve 14 and a pressure sensor 15 connect the engine crankcase with the inlet conduit 9 via an oil mist separator 16 according to the invention, which is shown in more detail in Fig. 2.

The separator 16 comprises an inner container 17, which is formed of a cylinder 18 and two end walls 19 and 20, each having a central opening in which a tubular shaft 21 and 22, respectively, is fixed. The interior channel 23 of the tubular shaft 21 forms an inlet for combustion gases and oil mist, while the channel 24 of the tubular shaft 22 forms an outlet for exhaust. Peripherally spaced openings 25 in the cylinder 18 form outlets for separated-out oil. The tubular shafts 21, 22 are mounted in bearings 26, 27 of a stationary outer container 28, which has a lower portion 29 forming a turbine housing. The lower tubular shaft 21 extends through the turbine housing 29 and carries a turbine rotor 30. The housing 29 has an inlet 31 and an outlet 32 for oil from the engine lubrication system. When the engine is in operation and lubricant is pumped through the housing 29, the turbine rotor 30 drives the shaft 21 so that the inner container 17 rotates in the outer container 28.

A cylindrical package 33 consisting of a plurality of layers of axial channels 34 is fixed to the lateral wall 18 of the inner container 17. It is also possible to integrate the cylindrical lateral wall 18 in the channel package 34. The channels 34 are open at their ends and communicate with radial passages 35, 36, which are defined between the respective end wall 19, 20, a pair of conical wall elements 37, 38 and intermediate, radially directed, peripherally evenly spaced intermediate walls 39. An enlarged portion of a channel package 33 with ten layers is shown in cross section in Fig. 3. The channels 34 are greatly enlarged. In realistic tests with an inner container with a channel length of circa 200 mm, an inner container radius of circa 100 mm and a rotational speed of circa 3 000 rpm, the radial dimension "r" of the channels should be slightly less than 1 mm, in order for there to be enough time for the

smallest oil drops to strike the channel walls before the gases have flown out through the channels and out into the outlet passages 36.

5 In the example shown in Fig. 3, the channels 34 in the channel package 33 are formed of alternating smooth and folded sheet metal cylinders 40 and 41, respectively, i.e. corresponding to the construction of corrugated cardboard. The channel package can also have a solid body, e.g. a ceramic body with drilled or cast cylindrical channels. The radial extent of the channel package amounts to approximately 20% of the radius of the first container. If the percentage is greater, there is a risk  
10 that the radially innermost channels will be so close to the rotational axis that the centrifugal force on the smallest drops will be too low to accelerate them out to the channel wall.

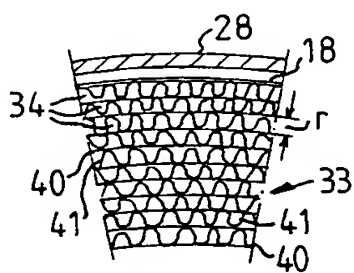
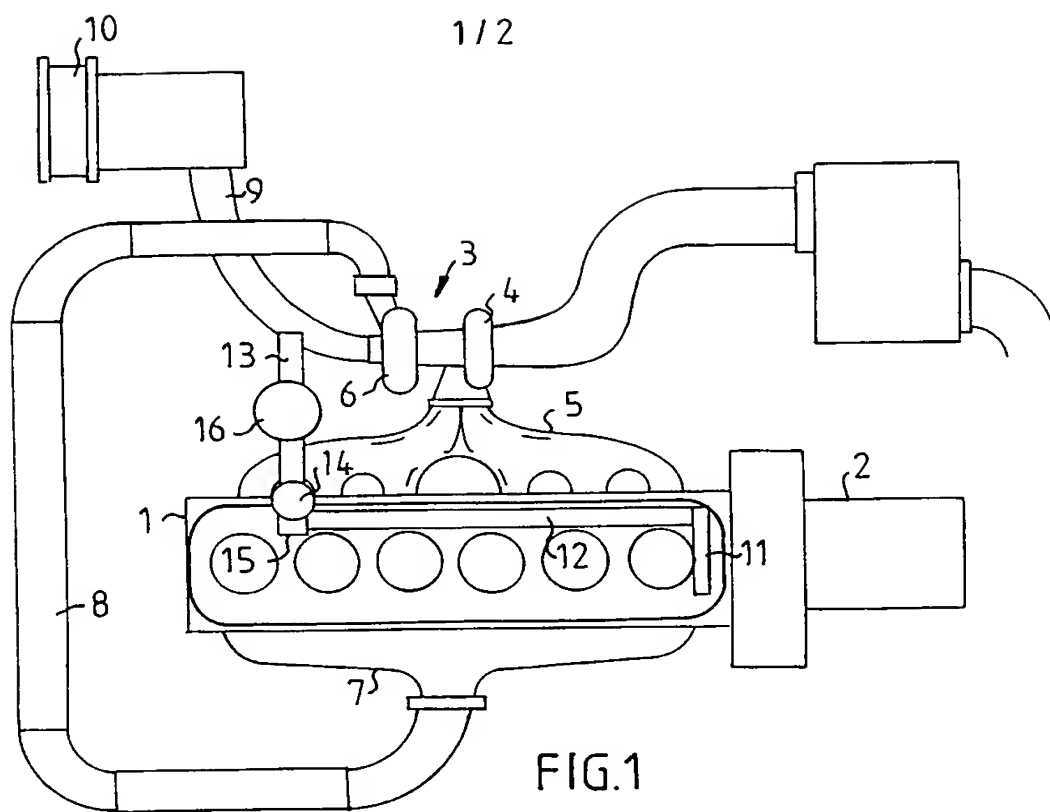
15 The oil, which is transported by the combustion gases through the channels 34 and under the influence of the centrifugal force as the inner container rotates, strikes the channel walls, is ejected through the openings 25, as indicated by the solid arrows, and runs down into the space between the containers to an outlet 42. From there the oil is led back to the engine crankcase. The combustion gases free of oil mist flow out through the upper tubular shaft 22, as indicated by the dashed arrow.

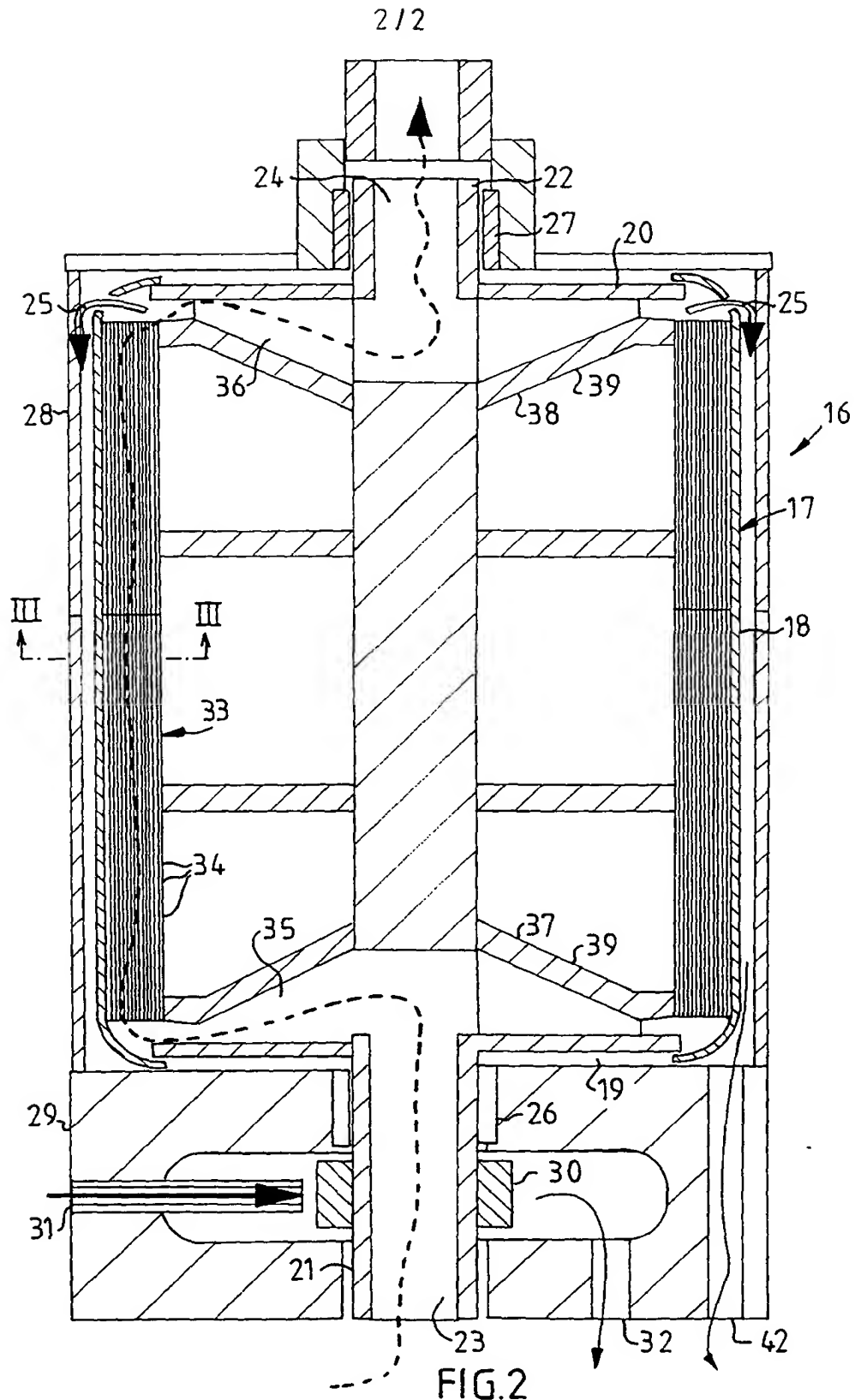
## Claims

1. Device for separating small drops of liquid from a flowing gas, containing liquid mist, comprising a first container (17), formed of a cylindrical lateral wall (18) and two opposite end walls (19, 20), said first container having an inlet (23) in one end wall for the gas/mist, a first outlet (24) in its other end wall for the gas and a second outlet (25) at or in the vicinity of the second end wall for liquid separated out of the gas, a second container (28) with means (26, 27) for rotatably mounting the first container in the second container rotationally symmetrically in relation to said inlet and said first outlet, and drive means (30) for rotation of the first container in the second container, characterized in that the inlet (23) and the outlets (24, 25) communicate with each other via a plurality of layers of peripherally spaced, narrow channels (34) extending in the direction of the rotational axis and being disposed at a radial distance from the rotational axis, said narrow channels having a radial dimension ( $r$ ) being adapted to their length, their radial distance to the rotational axis, the flow velocity of the gas and the rotational speed, so that at least the major portion of the liquid drops in the mist will have time to be deposited on the channel walls before they reach the outlet.
2. Device according to claim 1, characterized in that the inlet (23) has an inlet opening placed concentrically with the rotational axis of the first container, said inlet opening leading to a plurality of radial inlet passages (35) leading out to inlets of the channels (34), and that the channels have outlets opening, firstly, into a plurality of radial outlet passages (36), through which the gas can flow into an outlet opening (24) placed concentrically with said rotational axis, and, secondly, into a plurality of outlet openings (25), through which liquid deposited under the effect of the centrifugal force on the walls of the channels, can flow radially outwards to a space between the first container and the second container.
3. Device according to claim 2, characterized in that the containers (17, 28) are oriented with the rotational axis vertical so that liquid separated out can flow,

by the force of gravity, to the inlet end and out through a liquid outlet (42) from the second container (28).

4. Device according to claim 2 or 3, **characterized in** that the end walls have two axially spaced walls (19, 37 and 20, 38, respectively) which, together with intermediate radially directed wall portions (39), define said passages (35, 36).
5. Device according to one of claims 1-4, **characterized in** that the drive means are formed by a liquid turbine (30).
6. Device according to claim 5, **characterized in** that the end walls (19, 20) are joined to rotatably mounted hollow shafts (21, 22), the interiors of which forming inlet and outlet channels, respectively (23 and 24, respectively), and in that a turbine wheel (30) is fixed to one of said shafts.
7. Device according to one of claims 1-6, **characterized in** that the extent of the channel layers radially amounts to circa 20% of the radius of the first container (17).
8. Device according to one of claims 1-7, **characterized in** that the inlet (23) of the first container (17) is joined to a ventilation conduit from a crankcase of an internal combustion engine (1), and its outlet (24) is joined to an inlet air conduit to the engine.
9. Device according to claim 8, **characterized in** that the radius of the first container (17) is circa 100 mm and its length circa 200 mm, that the container is designed to be driven at a rotational speed of circa 3 000 rpm, that the radial dimension (r) of the channels (34) is less than 1 mm, and that the outermost channel layer is located at a maximum radial distance from the rotational axis.





## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/01394

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F01M 13/04, B01D 45/14, B04B 5/08

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F01M, B01D, B04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                   | Relevant to claim No. |
|-----------|--|-----------------------|
| X         | EP 0286160 A1 (BB ROMICO B.V.), 12 October 1988<br>(12.10.88), column 6, line 25 - column 7, line 33,<br>figures 1-5 | 1-7                   |
| Y         | --   | 8,9                   |
| X         | WO 9423823 A1 (ROMICO HOLD A.V.V.),<br>27 October 1994 (27.10.94), figures 3,4                                       | 1-7                   |
| Y         | --   | 8,9                   |
| X         | WO 9744117 A1 (ROMICO HOLD A.V.V.),<br>27 November 1997 (27.11.97), figure 1   | 1-7                   |
| Y         | --   | 8,9                   |

☒ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

|   |  |
|---|--|
| * Special categories of cited documents:  | "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  |
| "A" document defining the general state of the art which is not considered to be of particular relevance  | "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone   |
| "E" earlier document but published on or after the international filing date  | "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "&" document member of the same patent family  |
| "O" document referring to an oral disclosure, use, exhibition or other means  |  |
| "P" document published prior to the international filing date but later than the priority date claimed  |  |

|   |  |
|---|--|
| Date of the actual completion of the international search | Date of mailing of the international search report |
| 8 Sept 2000   | 16 -10- 2000                                       |

|  |  |
|--|--|
| Name and mailing address of the ISA:   | Authorized officer                                     |
| Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Jan-Axel Ylivainio/js<br>Telephone No. +46 8 782 25 00 |



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/01394

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages              | Relevant to claim No. |
|-----------|---|-----------------------|
| Y         | US 5542402 A (LEE ET AL), 6 August 1996 (06.08.96),<br>figures 1-8, abstract<br><br>--<br>----- | 8,9                   |

INTERNATIONAL SEARCH REPORT  
Information on patent family members

International application No.  
PCT/SE 00/01394

| Patent document cited in search report |         |    |          | Publication date |          | Patent family member(s) | Publication date |
|--|---------|----|----------|------------------|----------|-------------------------|------------------|
| EP                                     | 0286160 | A1 | 12/10/88 | SE               | 0286160  | T3                      |                  |
|  |         |    |          | AT               | 52936    | T                       | 15/06/90         |
|  |         |    |          | DE               | 3860159  | D                       | 00/00/00         |
|  |         |    |          | GR               | 3000514  | T                       | 31/07/91         |
|  |         |    |          | JP               | 1135516  | A                       | 29/05/89         |
|  |         |    |          | JP               | 2710624  | B                       | 10/02/98         |
|  |         |    |          | NL               | 8700698  | A                       | 17/10/88         |
|  |         |    |          | US               | 4994097  | A                       | 19/02/91         |
|  |         |    |          | US               | 5073177  | A                       | 17/12/91         |
| WO                                     | 9423823 | A1 | 27/10/94 | AT               | 162418   | T                       | 15/02/98         |
|  |         |    |          | AU               | 675535   | B                       | 06/02/97         |
|  |         |    |          | AU               | 6658894  | A                       | 08/11/94         |
|  |         |    |          | BR               | 9406173  | A                       | 09/01/96         |
|  |         |    |          | CA               | 2160576  | A                       | 27/10/94         |
|  |         |    |          | CN               | 1041282  | B                       | 23/12/98         |
|  |         |    |          | CN               | 1124462  | A                       | 12/06/96         |
|  |         |    |          | CZ               | 285941   | B                       | 15/12/99         |
|  |         |    |          | CZ               | 9502686  | A                       | 12/06/96         |
|  |         |    |          | DE               | 69408131 | D,T                     | 07/05/98         |
|  |         |    |          | EP               | 0693958  | A,B                     | 31/01/96         |
|  |         |    |          | SE               | 0693958  | T3                      |                  |
|  |         |    |          | ES               | 2111303  | T                       | 01/03/98         |
|  |         |    |          | NL               | 9300651  | A                       | 16/11/94         |
|  |         |    |          | US               | 5667543  | A                       | 16/09/97         |
| WO                                     | 9744117 | A1 | 27/11/97 | AU               | 2913797  | A                       | 09/12/97         |
|  |         |    |          | NL               | 1003157  | C                       | 00/00/00         |
| US                                     | 5542402 | A  | 06/08/96 | DE               | 69602873 | D,T                     | 14/10/99         |
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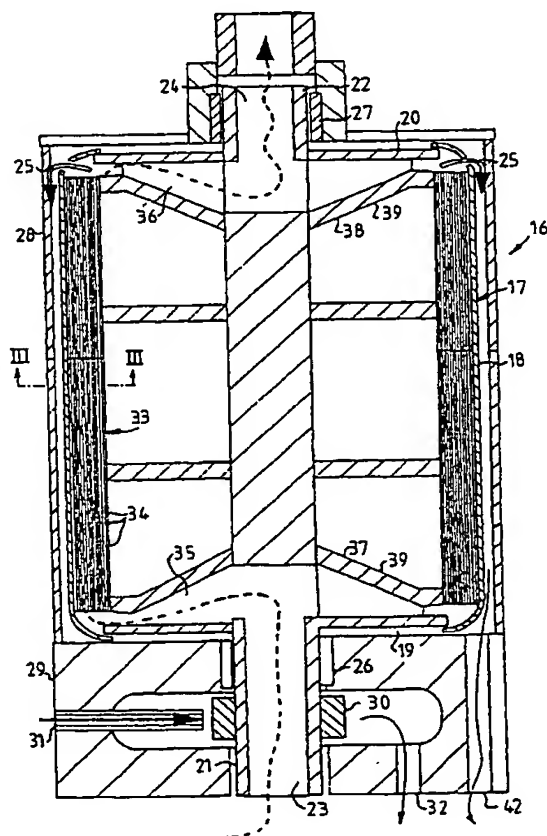
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[Continued on next page]

(54) Title: **OIL SEPARATOR FOR SMALL PARTICLES**



(57) Abstract: Device for separating oil mist from blow-by-gases from an internal combustion engine, comprising a rotating cylindrical container (17) with a central inlet (23) for gases with oil mist at one end and a central outlet (24) for gases and peripheral outlets (25) for separated oil at the other end. Between the inlet and the outlet, narrow channels (34) extend in several layers, spaced from the axis of rotation, through which the gas with oil drops flows. Under the influence of the centrifugal force the drops of oil are moved at the same time radially, the rotational speed and the length and radial dimension of the channels being adapted to each other so that the oil drops strike the channel walls before flowing out of the channels.

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                   | Relevant to claim No. |
|-----------|--|-----------------------|
| X         | EP 0286160 A1 (BB ROMICO B.V.), 12 October 1988<br>(12.10.88), column 6, line 25 - column 7, line 33,<br>figures 1-5 | 1-7                   |
| Y         | --   | 8,9                   |
| X         | WO 9423823 A1 (ROMICO HOLD A.V.V.),<br>27 October 1994 (27.10.94), figures 3,4                                       | 1-7                   |
| Y         | --   | 8,9                   |
| X         | WO 9744117 A1 (ROMICO HOLD A.V.V.),<br>27 November 1997 (27.11.97), figure 1   | 1-7                   |
| Y         | --   | 8,9                   |

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages           | Relevant to claim No. |
|-----------|--|-----------------------|
| Y         | US 5542402 A (LEE ET. AL), 6 August 1996 (06.08.96),<br>figures 1-8, abstract<br>--<br>----- | 8,9                   |

INTERNATIONAL SEARCH REPORT  
Information on patent family members

International application No.  
PCT/SE 00/01394

| Patent document<br>cited in search report |         |    |          | Publication<br>date |          | Patent family<br>member(s) | Publication<br>date |
|---|---------|----|----------|---------------------|----------|----------------------------|---------------------|
| EP  | 0286160 | A1 | 12/10/88 | SE                  | 0286160  | T3                         |                     |
|   |         |    |          | AT                  | 52936    | T                          | 15/06/90            |
|   |         |    |          | DE                  | 3860159  | D                          | 00/00/00            |
|   |         |    |          | GR                  | 3000514  | T                          | 31/07/91            |
|   |         |    |          | JP                  | 1135516  | A                          | 29/05/89            |
|   |         |    |          | JP                  | 2710624  | B                          | 10/02/98            |
|   |         |    |          | NL                  | 8700698  | A                          | 17/10/88            |
|   |         |    |          | US                  | 4994097  | A                          | 19/02/91            |
|   |         |    |          | US                  | 5073177  | A                          | 17/12/91            |
| WO  | 9423823 | A1 | 27/10/94 | AT                  | 162418   | T                          | 15/02/98            |
|   |         |    |          | AU                  | 675535   | B                          | 06/02/97            |
|   |         |    |          | AU                  | 6658894  | A                          | 08/11/94            |
|   |         |    |          | BR                  | 9406173  | A                          | 09/01/96            |
|   |         |    |          | CA                  | 2160576  | A                          | 27/10/94            |
|   |         |    |          | CN                  | 1041282  | B                          | 23/12/98            |
|   |         |    |          | CN                  | 1124462  | A                          | 12/06/96            |
|   |         |    |          | CZ                  | 285941   | B                          | 15/12/99            |
|   |         |    |          | CZ                  | 9502686  | A                          | 12/06/96            |
|   |         |    |          | DE                  | 69408131 | D,T                        | 07/05/98            |
|   |         |    |          | EP                  | 0693958  | A,B                        | 31/01/96            |
|   |         |    |          | SE                  | 0693958  | T3                         |                     |
|   |         |    |          | ES                  | 2111303  | T                          | 01/03/98            |
|   |         |    |          | NL                  | 9300651  | A                          | 16/11/94            |
|   |         |    |          | US                  | 5667543  | A                          | 16/09/97            |
| WO  | 9744117 | A1 | 27/11/97 | AU                  | 2913797  | A                          | 09/12/97            |
|   |         |    |          | NL                  | 1003157  | C                          | 00/00/00            |
| US  | 5542402 | A  | 06/08/96 | DE                  | 69602873 | D,T                        | 14/10/99            |
|   |         |    |          | EP                  | 0736673  | A,B                        | 09/10/96            |